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Investigating Wired's Investigation of Lost Spirits Accelerated Aging

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An interesting article appeared in Wired recently about the accelerated aging techniques being developed at the Lost Spirits distillery. It was flung around the web and possible shared sixteen thousand times yet didn't generate much critical comment except polarizing reactionary one liners. I was really disappointed that the spirits industry didn't take the time to better frame or contextualize what was being done at Lost Spirits because interest in spirits is at an all time high and there are so many supposed experts out there. The claims of the article bring up some real weighty issues. What happens if in six days we can make spirits taste like they're 20 years old? Can it really be done? How sophisticated were previous attempts? Does more age really make a product more extraordinary at the sensory level? And what would it mean for the industry?

The article made Lost Spirits seem like a sophisticated operation, but taking a look at previous works they've published on their investigations (part I, part II) shows a giant lack of involvement, poor research skills, hasty conclusions, gross reinventing of the wheel, and a general naivety. All those same descriptors have been used to describe my work as well so… After reading a lot about Lost Spirits, I hope they keep messing around and investigating things, but I also hope the rest of the industry and people that write about them are better able to frame and contextualize what they are doing. Standards right now in spirits journalism are very low. I really hope to taste the rum and would pay a premium price for a bottle in a heartbeat. Actually experiencing it would help make sure my ideas about aging can scale.

Some of the visceral reactions to the lost spirits article make me think that we haven't really been able to articulate what aged spirits mean to us. Is it all in their sensory values or is it largely a symbolic thing? Lost Spirits is trying to duplicate the sensory values but they are going to lose all the symbolism and much of the ability to retrieve memories. Were the spirits in oak during the Clinton era? I remember those days. Was it in oak since my birth year? So many people buy pricey birth year products and don't care if they taste good because it means so much more to them. Do we admire the producer's patience? Most other businesses erode all foresight to the short run, but distilleries keep massive inventories, think so far out into the next generation and that inspires people whether they can articulate it or

not. The spirits and wine industries are an exemplary and vital pillar of long run thought. They are a template we need to maintain if our governments are going to be able to plan for us and future generations. So much of a vineyardist's career is making decisions whose fruit only the next generation will taste. When those who truly appreciate a wine contemplate it, they think of all it symbolizes and not just its sensory values. All that it can symbolize is actually a large part of the price even though most consumers can't wrap their heads around it. We all practice very selective forms of aestheticism where we only focus on sensory values. *Exclusivity* of expensive bottles is *a thing,* and very cheap to write about, but don't let its attention whore nature distract you from the symbolic beauty of artifacts of great foresight.

So if we could pull off the sensory values of very old spirits on the cheap, would it really shake up the industry? After spending enough time in the wine business I'd say no. There are manipulated *wines of effort* and very pure *wines of terroir* and the latter, though smaller, riskier and dauntingly hard to produce, have rabid fans and are economically very significant. Said another way, there are commodity wines and fine wines and each has a place in the market. Near anything goes in commodity wine production and the largest amount of *science* is applied to them. They are also typically abstracted to lowest common denominator tastes. Commodity wines don't typically flirt with aging because aged wines are so often an acquired taste.

But aren't people going to get rich and isn't it going to shake everything up and give new producers a foot hold on the market? No, because if connoisseurship isn't dead, the laws of perfect information will suppress the price and producers practicing accelerated aging won't make significant amounts of extra money. Likely consumers will finally figure out what aging really means to them and there will be invigorated thought and education on the topic, thus moving the market. But hell, I do drink and pour handle upon handle of commodity spirits so bring it on if you can truly deliver on the sensory values. Have fun with your razor thin margins, you're still in commodity spirit production hell.

Aren't we making some assumptions that more aging is always better and the product will always be more enjoyable on a sensory level? Big assumptions that are bunk! In the wine world, wines gets too old all the time or a wine is old and very much alive, but just not extraordinary. Then there are adages like *there are no great wines, but only great bottles*. There is so much chaos in the systems that create wines, even during the aging process, that some hook left and some hook right. Maybe accelerated aging could be called controlled aging and it would eliminate the chaos and variability? If that is true, those products will alienate all the single barrel consumers who wanted to dip their nose into chaos whether they can articulate it or not. Do they say *fuck your inevitability engine!* with every drop they drink or are we all just taking most of our drams for granted?

I think on the technical end, Lost Spirits inspiration for pursuing fake aging came from their second investigation which I recently took a look at and wasn't very impressed by. One line in the paper grabbed me as significant.

> *We learned that the VOC range aroma compounds (primarily fruity esters) mature concentration appears to be predetermined prior to barreling.*

They kind of think of aging as a two part process (though it isn't). You have the most volatile fraction which is pretty much the distillate you put into the barrel and then you have the semi volatile fraction which comes from the wood and the chemistry gets a little more complex and even maddening. Their idea hinges on the volatile fraction just ending up in one predetermined *inevitable* equilibrium place while the complicated part, which is the significance of their process, is getting the semi volatile fraction where it wants to be (choosing how many years). The whole system is oversimplified and cuts out the role of the angels share though they do acknowledge that.

> *Davis says that's because the Model 1 does not allow for any substantial evaporation: Put in 100 liters of white dog and you get back about 98 liters of aged spirit. Without the "angel's share"—equating to about 50 percent evaporation in a 33 year old rum—it just doesn't seem possible to push a spirit any further.*

So there are dramatic acknowledged limitations but that doesn't void anything, though it does remind me of when you find a wine with interesting aroma and then you taste it, and its flabby because of not having enough acidity. Its just not a total package. It doesn't beg you to drink more, but could it be a fraction for blending? One reason I use this flabby analogy is because of the lack of angels share, I bet these spirits are flabby with an incomparable amount of total acidity relative to the spirits they are aiming at.

Lets back track before we dive into some science. The best look at aging for the layman I've ever seen came from a 1954 State Board of Equalization correspondence which I highlighted in a post called Barrel Aging / Rhetoric / Information Design. I was so taken by how well and concisely the paper summed up the process for a court case. So much tax money was riding on the explanation that it was whittled into a masterpiece. Is the barrel just a *manufacturing aid* to hold spirits that should be taxed or is it a *primary ingredient* in spirits making that shouldn't be taxed? The paper provides background and makes barrel aging seem less like voodoo. In Lost Spirits white papers, they had characterized spirits aging as something that little was known about and couldn't produce a bibliography.

For one stop shopping, lets turn to the 1980 4th edition of Technology of Wine Making which has spectacular sections on the accelerated aging of wine and the accelerated aging of spirits. This is no lost esoterica, the text is pretty much the most widely read industrial compendium on wine making (and brandy production) and has been the bible of countless producers. The chapters are excellent reviews of the literature and all end with a bibliography written by Maynard Amerine who was known to be obsessed with collecting literature and compiling bibliographies.

The funny thing about bringing up the great UC Davis bible of wine making and distilling is the the Wired article had a UC Davis professor of engineering, Greg Miller, vouch for Bryan Davis of Lost Spirits as "the real deal". It makes me wonder if Miller read any of the Lost Spirits papers or was aware of the seminal work on distilling done at UC Davis over the years.

The most interesting thing about the chapter on the accelerated aging of wine is the comments on how techniques, developed at the repeal of prohibition to jump start the industry

and more rapidly bring products to market, have become adopted, not as tricks or gimmicks or even associated with aging at all, but as absolutely standard wine making procedure across both fine and commodity wines. Examples of such techniques are early clarification, tartrate stabilization, and malo-lactic fermentation. So there is plenty of room for new ideas to be adopted in spirits production.

Other techniques widely used in wine production now, that relate more to what Lost Spirits is doing, involve the controlled micro oxidation of wine to develop more mature aromas. The techniques aren't one size fits all and the options get rather complex requiring deep involvement and lots of experimentation to be to cohesive and harmonic with a wine's style. Other more severe techniques like baking in the presence of oxygen (this resembles how Madeira is made) are sometimes used. Baking is not applied to 100% of the final product but rather to create blending stocks. Amerine et al. provides strong words of caution that "rapid aging cannot be applied by rule of thumb, but must be used with intelligence, skill, and care, adapting the severity of the various treatments to the product at hand."

To give a glimpse of what's been tried for wine over the years, lets quote a passage:

> *Most of the older treatments for accelerated aging involve some induced oxidation: exposure to sunlight or ultraviolet light, aeration at low temperature to allow easier oxygen absorption followed by raising the temperature to induce oxidation, use of ozone, hydrogen peroxide, catalysts, etc. Many of the treated wines have a "faded" or "over-aged" character which is unpleasent.*
> *[...]*
> *Singleton (1962) has reviewed physical methods of accelerated aging. Claims of success have been variable; overtreatments are invariably bad. Working with a variety of types of wine, Singleton and Draper (1963) found ultrasonic treatment in combination with various gases (air, oxygen, nitrogen, carbon dioxide, and hydrogen) tended to give a "scorched" flavor and undesirable results. Similarly, using ionizing radiation (Singleton 1963; Paunovic 1963) at sterilizing dosage produced color bleaching and off-flavors. Such exotic treatments appear to have little future unless the new flavors are considered attractive in their own right or are so restrained as to be an unidentifiable contributor to complexity. More promise is held for "dissecting" traditional aging into its component reactions and managing each for optimum results."*

So these guys experimented widely and truly knew their options to manipulate different reactions related to aging. The interesting comment here is about the creation of new flavors. Do the products of the Lost Spirit's accelerated aging produce any new aromas? And could they be features and not flaws? I've mused on the philosophy of flaws many times. Nothing can be a flaw until symbolic value is attached and it becomes *a regret, a missed opportunity, or a what could have been*. The wine industry is grappling with this issue. They've eradicated so many basic flaws that now critics have no experience with them and when they're found, they are mistaken for terroir. So when we are mimicking traditional aging, new aromas are flaws, unless we start to value them in their own right which we should never discount as a possibility.

I vividly remembered the weirdness of the section on the rapid aging of spirits and it was fun to revisit. I first read *Technology of Wine Making* eight years ago and I distinctly remember thinking *I want to taste that! All of that! I'd pay money!* The ideas are captivating and I could just imagine being a student back then and tasting your way through all the cryptically labelled bottles of Vernon Singleton's experiments. Andrew Quady of Vya Vermouth fame was a student back then and I bet he could tell use some cool stories. (One of Quady's student projects (1973) under distilling great, James Guymon, was cited in Amerine's bibliography at the end of chapter.)

From the section on rapid aging:

> *Various mechanical, physical, and chemical procedures have been used to age brandy more rapidly. Mechanical vibration (even by long ocean transport), variable temperatures, ultrasonics, adsorption, ion exchangers, ultraviolet and infrared have been tried (Singleton 1962). Ozone, peroxide, permangranate, electrolysis and metallic and biological catalyzers have also been used.*

So a lot of the same processes used for wine have also been used for spirits. We don't exactly know what Lost Spirits is using but here are some options (though the section of the Wired articled on *Prior Art* casts aside a few). One thing to note is that I don't remember any of the big modern distillation texts having any sort of similar sections on rapid aging.

> *No statistical data were given. The best that can be said is that some of the results have been encouraging. The economics of the treatment and unprejudiced sensory examination of the products have not always been adequately considered. Further work can profitably be done.*

This is very UC Davis language. They were optimists but the were definitely rigorous scientists and didn't fall in love with their ideas becoming biased. Some other distillation texts have no such language and sometimes you wonder if they truly every tried an idea or if it was just armchair speculation. Amerine et al. definitely sets a standard we should all aspire to.

> *The Soviet literature recommends using oak chips (treated with alkali or untreated) in the early aging of brandy. Oxidation of tannin substances during aging was responsible for the darkening of color. Ethanolysis of lignin and hydrolysis of hemicellulose also occurs. Ethanolysis of lignin results after oxidation in formation of aldehydes of the vanillin type.*
> *[...]*
> *This was considered the equivalent of 3 to 5 years' aging in wood. Lashki (1963) found that lack of oxygen during storage slowed the rate of aging but that too much oxygen resulted in loss of bouquet and the harmonious relation between components.*

The Soviet Union collapsed possibly because everybody was subjected to fake aged spirits. We see so many producers experimenting with oak chips but are they treating them to enhance the process? The part I omitted are the finer chemical parameters to use as a

template. As widely used as oak chips are, I don't think anyone in the new scene has deepened their involvement enough to treat them properly.

> *Heat treatment of young brandies of 20 days at 38°-40°C (100.5°-104°F) with or without oak chips (30 days) improved their sensory quality (higher volatile esters, aldehydes and furfural and less volatile higher alcohols) according to Abramov et al. (1976)*

Here, heat changes the reaction kinetics and modern immersion circulators make this easy to perform on the small scale. Lately I've been exploring this simple enclosed heating to hasten post distillation esterification in my cocktail centric distillates. In the Wired article, it was mentioned that the Lost Spirit's process could be used for "prototyping" but I have also developed a similar process where I simply sacrificed a portion of already aged spirit to a food dehydrator (low temp evaporation) to create a semi-volatile and non-volatile fraction of high fidelity. It works astoundingly well and is spectacularly affordable. It has already been worked into my Distiller's Workbook.

> *Pro and Etienne (1959) have shown that distilled spirits produced before 1954 can be dated with reasonable accuracy from their tritium contents. After 1954 the tritium content of the atmosphere was affected by hydrogen bomb explosions. Further, it is not possible to determine accurately the age of spirits which ave been diluted with post-bomb water.*

Are they messing with us? We call so many hacks these days "mad scientists" and these guys were hip to tritium contents?

The most interesting ideas in *Technology of Wine Making* were not in the rapid aging section, but another section titled *Changes During Aging*. I think this is the best hint of what Lost Spirits is doing.

> *Dzhanpoladyan and Petrosyan (1957) believe the aging process begins with the extraction of phenolic compounds from the wood, followed by their oxidation by atmospheric oxygen to peroxides and participation of the peroxides in subsequent reactions. Lignin was shown to decrease during aging and it is considered to play an especially important role as vanillin is one of its oxidation products.*

> *Petrosyan et al. (1976) found more free-radical products in aged brandies. Irradiation of wooden barrels with UV or γ-rays increased the oxidative reactions, enhanced maturation and gave higher free-radical products. Similar effects were found when the barrels were heated with oxygen for 12 days. Mndzhoyan et al. (1977) heat-treated the oak in an autoclave at 120°C(248°F) for 100 hours at 15 atm oxygen pressure. This reduced the cellulose and increased the lignin and aromatic aldehydes. Ethanol extracts of the treated wood were very high in aromatic aldehydes–comparable to 20 to 50-year-old brandy.*

This last paragraph is my best bet of what is being done at Lost Spirits. Their reactor simply accelerates the breakdown wood into aroma compounds and an extract is prepared. The extract is married with the rest of the distillate and then esterification is taken to a new equilibrium perhaps by baking. Keep in mind these particular experiments were not conducted as a means of faking aging, but rather to study the various reactions by creating some sort of nth degree scenario that made them easier to look at. Maybe they weren't considered for accelerated aging because expense made it nowhere near viable at the time.

I know I want to taste it, but would the results of a such a process really compare to a 20 year old rum? Could you spot the fake in a line up of real McCoys? Let's back track to James Guymon's classification of the changes occurring during aging:

> *1. Physical*
> *a. Losses by evaporation or soaking*
> *b. Changes due to concentration by evaporation or to dissolution of substances from the wood.*
> *2. Chemical*
> *a. Oxidation of original or extracted constituents.*
> *b. Reaction between original and oxidation product or dissolved substances.*

Well in the Lost Spirits process, we are already missing 1.a., the angels share, therefore critical ratios are out of wack. So there is the shell of an aged product, but none of the divine details. Van der Rohe said *God is in the details*. We have well intentioned stick figures, but no Vitruvian man. #GrapeDrink

When Chromatography and mass spectroscopy became more prevalent to the study of spirits, many of the papers started look at the correlation between objective counts of chemical compounds and their correlations to organoleptic assessments of sensory quality (because that is the final verdict). The researchers all threw up their hands in frustration. They are confident in their ability to count chemicals but they can't find straight forward correlations between the compounds and quality. Phenomenology kicks their ass. Our percepts are so infiltrated by recollections and other complexities, and though we can demonstrate astounding sensitivities at times, at other times we can have terrible contrast detection abilities. There is also a nitty gritty of attention within perception where just accumulating too much acetaldehyde can start to overshadow other rare and extraordinary aromas rendering the experience *flat*. You'd think the ratios would be pretty easy to figure out but they're not. They're also subject to little understood fixative effects where one obscure ester bridges another creating a unique percept. Everything becomes wildly interdependent and modeling it eludes our current abilities. Nothing beats traditional time in the barrel and the only thing that beats that is the massive amount of experimentation and data analysis large distilleries have privately conducted to maximize traditional time in the barrel.

The only thing I couldn't really figure out was the *oak catalyzed esterification* term that was thrown around in the article. I don't think it is an accepted industry term, but rather something Lost Spirits came up with themselves, possibly because they are confused and denying oxidation as a process. I suspect it implies the oak extraction product's ability to induce *acid catalyzed esterification*, which is a thing. There could also be some sort of heterogeneous

catalyst like tin, but that easily gets beyond my knowledge and I don't recall ever seeing anything like it in the beverage literature though this paper on producing perfume esters seems especially encouraging.

> *New-make distillate is distinguished by short-chain molecules called carboxylic esters and short-chain fatty acids. In a white dog or unaged whiskey, these have aromas that include overripe fruit and paint thinner and vinegar. Drinkable, but rarely worth savoring by the fire. Still, you need these chemicals to start with, because the interaction between these compounds and the wood in the barrel results in two processes: extraction and esterification.*

Various parts of the Wired article, like the above quote, embrace over simplifications. Extraction produces no magical results without oxidation as we saw in the classification of aging changes from James Guymon. Aging is about tons of slow oxidation reactions and then further reactions from those products. The new make distillate is also not at equilibrium but rather rearranging from the time it leaves the still. The whole process isn't a straight forward relay race you can simply run faster, its a dance with multiple partners trading partners all the time due to chaotic variables. Spirits aged differently during the Clinton administration than they did under Bush.

Lost Spirits doesn't seem to acknowledge oxidation as a process. In the section of the Wired article titled *Prior and Future Art*, the work of a competitor, Terressentia, uses "ultrasound and oxygenation to purportedly induce the production of long-chain esters", but "based on their patent, Terressentia is where we were five years ago," says Bryan Davis. For some reason that is the only acknowledgement of oxidation in the entire article and it relates to the techniques of their competitor. Is Lost Spirits naive and not aware their process uses oxidation or are they being cagey and evasive until they can make some money off their process? Or could I be wrong in interpreting Amerine et al.'s explanations that oxidation is absolutely a paramount part of the aging process. They could also be the victim of a shoddy writer who said, "Bags of sugar are easier to come by", regarding a distillery that makes a molasses based rum.

Did I even make any progress getting to the bottom of this?

Wired used 2,200 words, I'm guilty of using 3,900.

This entry was posted in **distillation** by **sjs**. Bookmark the **permalink [http://bostonapothecary.com/investigating-wireds-investigation-of-lost-spirits-accelerated-aging/]** .

4 THOUGHTS ON "INVESTIGATING WIRED'S INVESTIGATION OF LOST SPIRITS ACCELERATED AGING"

Jordan
on **June 7, 2015 at 6:59 pm** said:

Another point to be made is that raising temperature doesn't simply speed up reactions that occur at lower temperatures, it also opens up the energy landscape to new reactions that would have been exceptionally unlikely to occur at the lower temperatures.

Additionally, aiming for an equilibrium state should produce a different endpoint than barrel aging because the angel's share makes it a non-equilibrium process. Evaporation will reduce the concentration of some components, altering the equilibrium of various reactions. On a bulk level, the shifts in ABV that often occur as either water or ethanol preferentially evaporate should have major effects on which reactions are favored.

sjs
on **June 7, 2015 at 11:37 pm** said:

great points. the first point I had never considered. is there a name for that phenomenon or a case where it is more commonly encountered?

the angel's share is astoundingly important, but I don't think there are any research papers that exclusively look at it and what exactly evaporates. only ethanol and water or also significant amounts of acetaldehyde, ethyl acetate, and other congeners?

I know a lot of work was done on barrel entry proof to figure out what exactly was water soluble and what was ethanol soluble. tannin for example is more water soluble. slight changes have significant effects on the character of the aged spirit. I have a paper somewhere that lists all the entry proofs used to make American whiskey in 1968. it is from 72 different American whiskeys and there is quite a range.

Jordan
on **June 11, 2015 at 4:53 pm** said:

Energy landscapes are most often used to describe protein folding, where a single polypeptide can assume a huge number of different physical confirmations , each with a different free energy state. It's basically extrapolating the basic free energy diagram to account for the multiple paths that can be taken. Since spirits are complex mixtures, it seems useful to think about their potential reactions in similar terms – different pairs (or more) of molecules that each have their own equilibria, which continuously change the landscape. Raising the temperature smooths out the landscape because both the starting and ending points are higher, which effectively makes the barriers to each reaction smaller. Because that makes new reactions more likely, those will change the equilibria of the reactions that would have been more

prevalent at lower temperatures.

A quick look at Whisky Technology suggests that acetaldehyde evaporation is significant, above 30% per year. I need to dig through my references to find some of the papers on the subject, but I seem to remember that it was a major factor in reducing the 'youthful' qualities of new make spirit. On the flip side, there was the abortive experiment to wrap casks in saran wrap: http://www.dramming.com/2012/06/17/whisky-myths-debunked-8-diageos-cling-film-casks/

sjs
on **June 12, 2015 at 12:21 pm** said:

I'm starting to understand your energy landscape idea. Its bring me back to reading chemist Peter Atkins book Reactions.

I've always wondered what evaporated in spirit casks beyond ethanol and water. I suspect acetaldehyde can evaporate but it can also oxidize into other forms and I suspect that is very significant. Robert Leaute mentioned that Cognac fermentations should be carried out at specific temperatures to maximize the evaporation of acetaldehyde during fermentation.

I remember distilling a Saunternes as an experiment. the fresh distillate was foul and unbelievably acrid, from all the acetic acid and acetaldehyde and I simply put it in a sealed canning jar and ignored it for many months. after many months it dramatically moved towards a new equilibrium and was far more palatable (having started off absolutely scary). there was likely a dramatic change in the acetaldehyde with no evaporation taking place.